NUMERICAL TOOLS FOR MULTI-SCALE MATERIAL DESIGN AND STRUCTURAL TOPOLOGY OPTIMIZATION

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ABSTRACT

Computational Material design is a new research line in which the classical paths of choosing existing materials for applications, including design of prototypes design and their testing, is replaced or improved by the simultaneous design of material and applications. In this work we explore methods for development of efficient computational material catalog and micro/macro structural topology design methods to design materials and components with the optimal structural properties for a specific application.

Therefore, the aim of this work is to develop numerical tools for designing the micro-structure material and the macro-structure topology in such a way that a representative cost function is minimized. In our applications, a structural compliance is considered first, which means that the structural stiffness is maximized for a specific weight. An online-offline computational strategy, based on the off-line construction of a computational catalog, for the microstructural optimization problem, and the on-line resolution of the structural equilibrium, is proposed.

A numerical strategy, based on the topological derivative concept, for designing the micro and macro topologies is also proposed. The associated non-linear problem is solved by means of a fixed-point algorithm based on an alternate-directions strategy.

A number of representative numerical simulations show the performance and possibilities of the proposed method.

References

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